

Science Laboratories: Waste Disposal Guidance

What are your obligations?

It is important to realize that you may be held legally liable for your hazardous waste and any damage it creates even after it leaves your school and is transported to a treatment, storage, or disposal facility. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, you can be required to contribute to the costs of cleaning up any contamination resulting from your wastes wherever they may end up. Therefore, it is important to ensure compliance with the regulations and that the business you pay to dispose of your wastes is approved and in full compliance.

Source: EPA Region 8 HWManagementToolkitFinal.pdf

DO NOT:

DO:

<ul style="list-style-type: none">• DO NOT dispose any wastes in sinks or drains without prior approval from the local wastewater treatment department.	<ul style="list-style-type: none">• DO maintain accurate records from the point of waste generation to waste disposal & final disposition.¹
<ul style="list-style-type: none">• DO NOT dispose any wastes in sinks and drains that discharge to a septic tank system.	<ul style="list-style-type: none">• DO treat/neutralize wastes when permitted by meeting certain requirements.²
<ul style="list-style-type: none">• DO NOT dispose of any chemicals in the trash without assurance from your regulatory authority and solid waste disposal service.• DO NOT dispose of any chemicals by evaporation in a fume hood or other location.	<ul style="list-style-type: none">• DO store your wastes properly prior to disposal or recycling:<ul style="list-style-type: none">○ Use containers in good condition and compatible with the wastes.○ Keep closed at all times except when adding or removing wastes.○ Place hazardous waste containers on an impervious surface (pavement, tile) without floor drains.
<ul style="list-style-type: none">• DO NOT accumulate more than 6,000 kg of hazardous waste for more than 180 days.³	<ul style="list-style-type: none">• DO follow storage limits and permissible accumulation times.

¹ Make sure the people you pay to dispose of your wastes are in full compliance with the law.

- Check the company's compliance status via EPA's Enforcement and Compliance History Online, at ECHO, at www.epa.gov/echo/.
- Ask them to provide written documentation of all necessary permits, and maintain copies of these.
- Inquire about their record keeping practices for transport and disposal.
- Ask them about their treatment and disposal practices, and the final disposition of your wastes.
- Inquire about any special conditions or minimum pick-up requirements that may apply to your wastes.
- Make arrangements by phone before shipping any amount

² See section below, "Neutralize Hazardous Wastes."

DO NOT:

DO:

<ul style="list-style-type: none"> DO NOT mix incompatible wastes (e.g. ignitables and oxidizers). 	<ul style="list-style-type: none"> DO segregate individual and incompatible hazardous waste streams.
<ul style="list-style-type: none"> DO NOT move any chemicals that have crystallized! Crystallized chemicals may explode if not handled with extreme care. Contact local officials and arrange for a disposal contractor to remove the crystallized chemicals. 	<ul style="list-style-type: none"> DO keep nonhazardous wastes separate from hazardous wastes. DO store recyclable wastes – like recoverable metals and solvents – separately from each other, as well as apart from nonrecyclable wastes.
<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> DO store or package waste in small containers to prevent or reduce: <ul style="list-style-type: none"> decomposition of reactive compounds breakage exposure to hazardous materials
<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> DO package severe hazardous wastes (extreme poisons or toxins, severe flammable, corrosive or stench characteristics, strong oxidizers, or carcinogens) in 3 layers: <ul style="list-style-type: none"> place each chemical container in a clear heavyweight, sealable plastic bag; place the bag & contents on a thin layer of cat litter in the bottom of a paint can; fill the remaining portion of the can with cat litter; place the lid on the paint can and label the can clearly with the chemical name, chemical formula and hazard risk.⁴

http://www.kdheks.gov/waste/download/school_chemical_guidance_book_1001.pdf

WASTE CHEMICAL DISPOSAL GUIDANCE FOR SCHOOLS

Kansas Department of Health & Environment

³ This is if you want to remain a “small quantity generator.” The time may be extended to 270 days your waste must be transported over 200 miles. See Appendix A if you can’t meet the criteria for a Small Quantity Generator (SQG).

⁴ **Seven-Step Plan to Clean Up Your Chemical Storage Area** (Step 4), <http://www.flinnsci.com/Sections/Safety/chemicalSafety/sevenStepPlan.asp>. For more disposal details, refer to Flinn’s 2006 Catalog/Reference Manual. First read about your options on page 1068 and if you want to dispose of small quantities of chemicals, refer to the disposal procedures found on pages 1069–1093. [2006 Flinn Scientific Chemical & Biological Catalog Reference Manual](#). Science teachers may request a catalog at http://www.flinnsci.com/catalog_request.asp.

What defines hazardous waste?

A hazardous waste is a solid, liquid or gas that could pose dangers to human health or the environment. Several federal, state and local agencies may regulate a laboratory's hazardous materials and wastes. These include the federal Environmental Protection Agency, the Utah Department of Environmental Quality, the local fire department, the local air quality authority and the local sewer district. Not complying with hazardous waste regulations can lead to significant fines and penalties. It is important that laboratory managers take steps to avoid violating regulatory requirements.

King County - Lab Waste Management Guide

<http://www.govlink.org/hazwaste/publications/LabGuidelinesRevAugust06.pdf>

Flinn Scientific, Inc. MSDS

http://www.flinnsci.com/search_MSDS.asp

OR

NIOSH Pocket Guide to Chemical Hazards, Available at

<http://www.cdc.gov/niosh/npg/default.html>

While your obligations with regard to hazardous wastes may seem severe, they also present a “teachable moment.” The disposal of waste or outdated chemicals can be a valuable educational experience for teachers and students alike. Formal instruction in the disposal of waste chemicals should be a fundamental part of every experimental lesson.

Neutralize Hazardous Wastes

A Small Quantity Generator may take advantage of these options:

1) **Sanitary Sewer** - Some chemicals (acids or bases) may be neutralized and disposed to the sanitary sewer. This disposal option should be approved by the local waste water treatment officials prior to disposal. This may not be an option for some small communities that do not have sufficient treatment capacity at the waste water treatment plant for these types of wastes.

2) **Local Landfill** - If disposal at the local landfill is selected, the school will need to obtain a “special waste disposal authorization” Utah Department of Environmental Quality.[? Contact ??] to make these arrangements. The waste may need to be solidified or packaged properly before being taken to the landfill. The landfill will give the final approval before accepting the waste for disposal.

Waste Chemical Disposal Guidance For Schools Page 5

http://www.kdheks.gov/waste/download/school_chemical_guidance_book_1001.pdf

Kansas Department of Health & Environment

Disposal Guidance for Specific Chemicals or Chemical Groups

The following disposal guidance for specific chemicals is almost entirely directly quoted from:

http://www.govlink.org/hazwaste/publications/LabGuidelines_05.pdf

Laboratory Waste Management Guide

Dave Waddell

Local Hazardous Waste Management Program in King County
Technical Assistance and Pollution Prevention Team

Acetone Used in Glassware Cleaning

Analytical laboratories often use acetone when cleaning glassware. Acetone is ignitable and is a federally-regulated F003 dangerous waste. It may not be rinsed off the glassware and put down the drain. (Flammable liquids are prohibited from sewer disposal.) Instead, collect acetone rinsate and dispose of it as ignitable dangerous waste.

Disposal of Alcohols

Alcohols, such as ethanol, methanol and isopropanol, are common organic solvents used in laboratories. All are flammable and are regulated as ignitable hazardous waste at concentrations above 24 percent in water. Additionally, methanol and isopropanol are category D toxic hazardous wastes under the Washington Dangerous Waste Regulations and are considered hazardous waste at a concentration above 10 percent in water. Alcohol solutions that characterize as hazardous wastes are prohibited from discharge to the sewer. Dilution of waste alcohol **solely** to bring its concentration below these levels is prohibited. Dilution of alcohol that is done **as part of the “industrial process”** at the lab is allowed and its concentration is not evaluated for waste characterization until the process is complete.

For example, in teaching laboratories, what would be considered “waste” ethanol can be mixed with water to demonstrate the Particle Theory. The final volume of the solution is less than the predicted sum of the volumes of the separate solutions because the alcohol and water molecules arrange in a different geometry that is more closely packed. At the point the demonstration is completed, the ethanol concentration is determined. If the final ethanol concentration is below 24 percent, it will not be considered an ignitable waste and would be acceptable for discharge to the sewer.

Technologies are available for removing stains, dyes and cell debris from reagent grade ethanol, methanol and isopropanol used in Cytology and Histology stain lines, thus permitting the same alcohol to be reused indefinitely. In addition, these systems will remove lipids (fats) and marker inks commonly found in tissue processor waste alcohol. Commercially available systems include the filtration-based Benchtop Alcohol Recycling System™ from Creative Waste Solutions and fractional-distillation-based systems from B/R Instruments, CBG Biotech and CMT Environmental Services. Suncycle Systems has also developed an alcohol cartridge recycling system for tissue processors. Descriptions of these systems can be found by visiting the Sustainable Hospitals website at http://www.sustainablehospitals.org/cgi-bin/DB_Report.cgi?px=W&rpt=Cat&id=30

Isopropanol is often used as a disinfectant in medical labs. Surfaces are wiped down with a cloth or paper towel holding isopropanol, with much of the isopropanol evaporating off the cloth and counter. When the cloth wiper is no longer useful, put the rag in your shop towel collection container for laundering, or wring out the free liquids into an ignitable hazardous waste collection container. The remaining cloth or paper wiper will typically be acceptable for disposal as solid waste.

Management of Aldehyde Wastes

The most common aldehyde wastes coming from labs are ten-percent buffered formalin (3.7 percent formaldehyde solution,) two-to-four percent glutaraldehyde solutions and 0.5 percent ortho-phthalaldehyde (OPA) solutions (typically Cidex® OPA.) Formalin is used as a tissue preservative. Ortho-phthalaldehyde and glutaraldehyde are used as cold sterilants.

Formalin

Formaldehyde solutions can never go into septic systems or storm drains. Solutions that are more than 1.0 percent formaldehyde must either be disposed as hazardous waste or chemically treated to reduce the formaldehyde concentration to acceptable levels for sewer discharge.

Chemical Treatment of Formalin

Formalin is readily treatable. Solutions should be diluted with water to fewer than five percent formaldehyde before chemical treatment. Commercially available chemical treatment products that will "detoxify" formalin are listed below (although this list may not be exhaustive):

- "Neutralex™" - produced by Scigen/Tissue Tek 800-725-8723 ext. 7268
- VYTAC™ 10F" - by Baxter Healthcare Corp 800-964-5227
- "Aldex®" – by Waste & Compliance Management, Inc. 866-436-9264 (turns the formalin into a solid for disposal as solid waste)
- "Formalex®" - by S&S SASCO 800-624-8021 (notes: requires filtering and may require pH adjustment; decertified as a treatment technology in California)
- "D-Formalizer®" - by Surgipath 800-225-3035 (not recommended due to release of low levels of hydrogen sulfide gas)

According to product data, these compounds will reduce the concentration of a treated sample of formalin to under 0.1 percent formaldehyde, though the times required for this vary. According to product literature, both "Neutralex™" and "D-Formalizer®" will reduce the concentration to less than 25 parts per million (ppm) in 15 minutes. Since the sewer limit is 0.1 percent residual formaldehyde, the treatment compounds can be diluted below the manufacturer's recommended concentration. For Neutralex™, one packet is described as treating one gallon of buffered formalin to 15 ppm. However, since the sewer limit is 1000 ppm, the packet can actually treat 50 times as much formalin and still have the resulting solution meet the local sewer limit.

Alternatives to Formalin

Another option is to request less hazardous preservatives from suppliers. Safer substitutes for formaldehyde can reduce the risk of harmful exposures and potentially eliminate disposal problems. Propylene glycol-based solutions are often used for soaking solutions on specimens that have been preserved in formalin. In histology settings, Prefer® or

Safe-Fix® have been used as effective substitute preservatives to formalin on small specimens but have been found to be less effective on larger tissues due to their slower penetration rate.

Glutaraldehyde

Based on equivalent concentration criteria, glutaraldehyde solutions designate as hazardous wastes at concentrations of 1.0 percent in water. However, research on biodegradability tests found that two-to-four percent glutaraldehyde sterilant solutions broke down readily to nonhazardous by-products in the sewer system. [Balogh, 1997] Therefore, cold sterilant solutions containing less than four percent glutaraldehyde may be acceptable for discharge to the sewer system. Glutaraldehyde solutions can never go into septic systems or storm drains. Solutions of over 4.0 percent glutaraldehyde must either be disposed as hazardous waste or chemically treated to reduce the glutaraldehyde concentration to acceptable levels for sewer discharge.

Chemical Treatment of Glutaraldehyde

Glutaraldehyde is readily treatable using the same methods described above for formalin. Dilute solutions with water to less than five percent glutaraldehyde prior to chemical treatment.

Ortho-Phthalaldehyde

Ortho-phthalaldehyde is commonly used as a substitute for glutaraldehyde in sterilization. It works more quickly, remains bioactive longer and is much less of an irritant to the eyes and nasal passages. O-phthalaldehyde solutions demonstrate aquatic toxicity. Based on equivalent concentration criteria, o-phthalaldehyde solutions designate as hazardous wastes at concentrations of 0.01 percent in water. Therefore, cold sterilant solutions containing more than 0.01 percent o-phthalaldehyde are not acceptable for discharge to a sewer system. O-phthalaldehyde solutions can never go into septic systems or storm drains. One of the most commonly used o-phthalaldehyde-based cold sterilants is Cidex® OPA. Cidex® OPA contains 0.55 percent o-phthalaldehyde which exceeds the allowable discharge limit.

Chemical Treatment of Ortho-Phthalaldehyde

O-phthalaldehyde is readily treatable by adding the amino acid glycine to it at a rate of 7 grams per gallon of waste o-phthalaldehyde (half a tablespoon per quart.) Once o-phthalaldehyde has been deactivated, typically after 5 minutes contact with glycine, it may be acceptable for discharge to a sanitary sewer (check local regulations).

Aldehyde Spill Management

Glutaraldehyde and formalin spills can be deactivated with one of the commercially-available treatment chemicals listed above. O-phthalaldehyde spills can be deactivated by adding 25 grams of the amino acid glycine to each gallon of spilled material.

Ethidium Bromide Management

Ethidium bromide (EtBr) is commonly used in molecular biology research and teaching laboratories. While it is not regulated as dangerous waste, the mutagenic properties of this substance may present a hazard when poured down the drain or placed in the trash. Based on these considerations, the following disposal procedures for ethidium bromide are recommended:

Disposal of Pure Ethidium Bromide

Unused Ethidium Bromide (EtBr) should be collected for disposal with a hazardous waste vendor.

Disposal of Electrophoresis Gels

Trace amounts of EtBr in electrophoresis gels should not pose a hazard. Higher concentrations, e.g., when the color of the gel is dark pink or red, should not be placed in laboratory trash. The disposal recommendations for gels are:

- Less than 0.1% EtBr: dispose as solid waste with approval from the local solid waste authority.
- More than or equal to 0.1% EtBr: place in sealed bags and label for disposal as hazardous waste.

Disposal of Contaminated Gloves, Equipment and Debris

Gloves, test tubes, paper towels, etc., that are contaminated with more than trace amounts of EtBr should be placed in sealed bags and labeled for hazardous waste disposal.

Disposal of Ethidium Bromide Solutions

Aqueous solutions with $<10\mu\text{g/ml}$ ($<10\text{ ppm}$) EtBr can be discharged to the sewer. Aqueous solutions containing $>10\mu\text{g/ml}$ ($>10\text{ ppm}$) EtBr: Chemically treat using the decontamination procedures listed below and dispose to the sewer or collect for disposal as dangerous waste. All aqueous solutions released to the sewer must meet local sewer discharge requirements for metals, pH, etc. *Solvent* solutions containing any amount of EtBr; or EtBr mixed with a radioactive isotope are restricted from discharge to the sewer and should be disposed as ignitable dangerous waste.

Treatment of Ethidium Bromide Waste

Ethidium bromide waste solutions can be treated to increase their concentration before disposal, thereby reducing disposal costs, or deactivated to eliminate their hazardous characteristics before discharge to the sewer. Most universities recommend filtration over deactivation as the safer method. Filtering aqueous EtBr waste solutions through activated charcoal is simple and effective. The filtrate may be poured down the drain. Commercially available filtration systems include FluorAway™, the S&S Extractor™ and The Green Bag® Kit.

- Filter the EtBr solution through charcoal filter.
- Pour filtrate down the drain.
- Place charcoal filter in a sealed bag (e.g., zip-lock) and collect for disposal as hazardous waste.

A safety note: if using house vacuum to speed filtration, do not use a standard Erlenmeyer or side-arm filtering flask. A filtration flask capable of withstanding vacuum must be used to prevent implosion.

Deactivating EtBr Solutions

All EtBr solutions that are deactivated should be neutralized and poured down the drain with copious amounts of water. Deactivation may be confirmed using ultraviolet (UV) light to detect fluorescence. There are two recognized methods for deactivation, the Lunn and Sansone Method [Lunn and Sansone, 1994, p. 185]⁵ using hypophosphorus acid and sodium nitrate, and the Armour Method that uses household bleach. [Armour, 1996, p.

⁵ Lunn, George and Eric B. Sansone. *Destruction of Hazardous Chemicals in the Laboratory*, 2nd Edition. New York, NY: John Wiley and Sons. 1994.

214]⁶ Though the Armour Method is the simplest, it is somewhat controversial since found traces of mutagenic reaction mixtures using this method. [Lunn and Sansone, *Analytical Biochemistry*, 1987, vol. 162, p. 453]

Decontamination of Ethidium Bromide Spills

EtBr spills can be decontaminated with a solution of 20 ml of hypophosphorus acid (50%) added to a solution of 4.2 g of sodium nitrate in 300 ml water. Prepare fresh solution the day of use in a fume hood. Wear rubber gloves, lab coat, and safety glasses. Turn off electrical equipment before decontamination.

- Soak paper towel in decontamination solution, place on contaminated surface, and scrub.
- Scrub five more times with paper towels soaked in water, using fresh towel each time.
- Place all towels in a container and soak in fresh decontamination solution for one hour.
- Test squeezings from final towel scrub and mixture for fluorescence; repeat procedure with fresh decontamination solution if fluorescence is present.
- Neutralize with sodium bicarbonate and discard as nonhazardous aqueous waste.
- This procedure has been validated for EtBr-contaminated stainless steel, Formica, glass, vinyl floor tile surfaces, and filters of transilluminators.

Alternatives to Ethidium Bromide

Ethidium bromide (EtBr) is a dangerous compound due to its mutagenicity. SYBR Safe™ is a potentially safer alternative. Data on mutagenicity and EcoToxicity show SYBR Safe™ is much less mutagenic than EtBr and is acceptable for discharge to the sanitary sewer. Several major institutions have switched from EtBr to SYBR Safe™ with good results in DNA analysis. However, SYBR Safe™ is less effective than the traditional EtBr staining for RNA analysis.

High Pressure Liquid Chromatography Waste

High pressure liquid chromatography (HPLC) analyses are typically done with a mixture of water, acetonitrile and methanol. Both acetonitrile and methanol are flammable solvents. Some methods add 0.1 percent trifluoroacetic acid to the mixture. Acetonitrile concentrations in the resulting liquid waste range from 10 to 40 percent and are prohibited from discharge to the sewer. There are a number of ways to reduce the volume of solvent waste from HPLC analyses. These include modifying the size of columns used in the process, distilling and reusing acetonitrile, and separating water from the solvent waste. If the water remaining after separation contains <100 milligrams/liter of acetonitrile, it likely may be discharged to the sewer.

Disposal of Wastes Containing Sodium Azide

Some commonly used laboratory reagents contain sodium azide. Sodium azide is a category-B toxic compound due to oral-rat LD50 data, so in a mixture it will designate at a concentration of 0.1%. Any waste containing over 0.1% sodium azide must either be treated to remove the toxicity characteristic or disposed as a hazardous waste. It also can

⁶ Armour, Margaret-Ann. *Hazardous Laboratory Chemicals Disposal Guide, 2nd Edition*. Boca Raton, FL: Lewis Publishers. 1996.

form explosive metal azides, as is discussed in the *Managing Hazardous Chemicals On-site* section below.

Enterococcus Agar

Here is a common list of constituents and concentrations, expressed in amount per liter.

Enzymatic Digest of Casein13.0 g

22 King County - Lab Waste Management Guide

Enzymatic Digest of Soybean Meal5.0 g

Yeast Extract6.0 g

Dextrose.....3.0 g

Dipotassium Phosphate4.0 g

Sodium Azide0.4 g

Agar10.0 g

Through this calculation: $0.4 \text{ grams/liter} = 400 \text{ mg/L} = 400 \text{ ppm} = 0.04\%$, we find the final sodium azide concentration to be below the 0.1% concentration where it would designate as a hazardous waste. Therefore, waste *Enterococcus* agars do not have to be counted or disposed as hazardous waste.

Alkaline Iodide Azide (AIA) Reagent for the Winkler Dissolved Oxygen Titration

Here is a common list of constituents and concentrations in the AIA reagent before being added to a water sample for dissolved oxygen analysis.

Water50.0 percent

Potassium Hydroxide.....40.0 percent

Potassium Iodide9.0 percent

Sodium Azide0.6 percent

Since the sodium azide concentration is over 0.1% with a pH greater than 12.5, expired or unused stock reagent will be regulated as a corrosive, Washington-state-only toxic hazardous waste. When used as a titrant, it is sufficiently diluted during the analytical process to fall below the 0.1% concentration limit. The waste solution generated by the Winkler Method must be counted as a corrosive hazardous waste if its final pH is over 12.5, but it can then be neutralized under the treatment-by-generator guidelines and disposed to the sewer.